POWER PS SONIC®

Battery Guide

www.power-sonic.co.uk

Power-Sonic Battery Guide

Contents

Cell / Battery Description

Cell – A Cell is the simplest operating unit in a battery. It consists of one or more positive plates, an electrolyte, one or more negative plates, separators between plates of opposite polarity, and a container. The nominal voltage of a lead acid cell is 2v.

Commonly, the term battery also applies to a single cell if it constitutes the entire electrochemical storage system.

Example of a VRLA cell

Battery – Two or more cells enclosed in a container and electrically interconnected in an appropriate series/parallel arrangement to provide the required operating voltage and capacity.

Lead Acid batteries are composed of the following sub-technologies, according to the battery design and the manufacturing process:

- Flooded type (open/vented)
- Sealed Lead Acid type, however the more accurate term is Valve Regulated Lead Acid normally abbreviated to VRLA.

The main physical difference between the two technologies is that the flooded type has free flowing electrolyte whereas the electrolyte is immobilised in the VRLA type.

Typical 12v Battery
(6 cells internally connected in series)

Flooded Technology

- Uses high Antimony, low Antimony or Calcium Lead alloys or a combination of Calcium and low Antimony (hybrid) Lead alloys
- Requires maintenance
- Its entire electrolyte volume is free to move within the cell with nothing to prevent the escape of hydrogen and oxygen gases normally lost during charging
- Is spillable, and therefore can only be operated in an upright position
- Normally requires a separate battery room
- Older Technology

VRLA Technology

- Cells are sealed using special pressure release valves and should never be opened
- Typically uses Calcium/Lead alloys
- Low maintenance – "Maintenance Free"
- Uses a recombination chemical reaction to prevent the escape of hydrogen and oxygen gases normally lost in a flooded lead-acid battery (particularly in deep cycle applications)
- Is non-spillable, and therefore can be operated in virtually any position
- Safe

VRLA batteries can be categorised further and there are basically two types:

- Batteries with the electrolyte immobilised in a special glass mat separator are commonly known as VRLA AGM (absorbent glass mat) batteries
- Batteries in which the electrolyte is immobilised by a Gel is commonly known as VRLA Gel batteries

There are two main features of a VRLA battery

One, it is sealed and uses special rubber valves to release pressure under abnormal overcharge conditions.
Two, it uses a chemical recombination system to prevent the escape of internal gases.

Operational Positions

May be used in any operational position except for the inverted position.

Design Life

Float Service

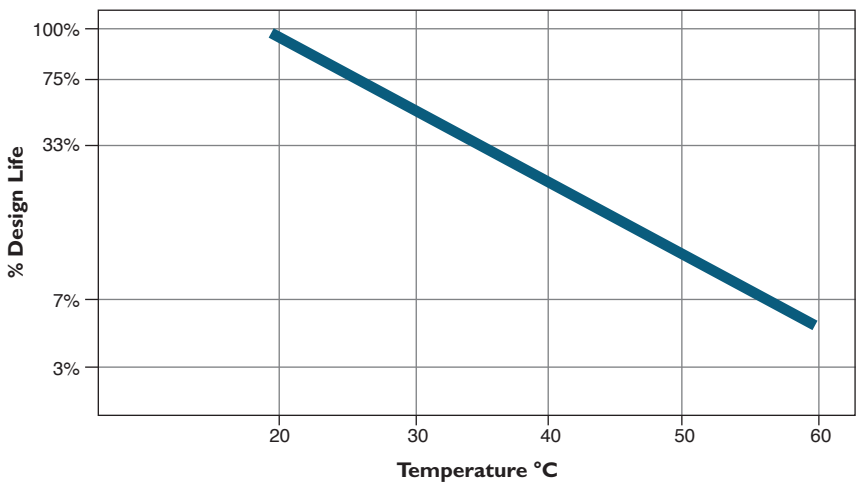
The definition of design life is the service life time, in years, before the battery capacity falls below 80% of its initial rated capacity.

Eg. For a 100ah battery, the end of life is reached once the capacity of the battery is reduced to 80ah.

Temp Effect On Battery Life

Heat has a dramatic effect on battery life and as a general rule of thumb, the life of the battery is reduced by 50% for every 10 deg rise in temp from a base temp of 20 deg C.

Temperature Vs Life



Cyclic Service

In cyclic applications the battery will reach end-of-life after a defined number of cycles. This number is dependant upon the depth of discharge of each cycle. The deeper the discharge, the less number of cycles to end-of-life conversely the lower the depth of discharge the more cycles to end of life.

The depth of discharge is expressed as the percentage of the battery capacity required per duty cycle.

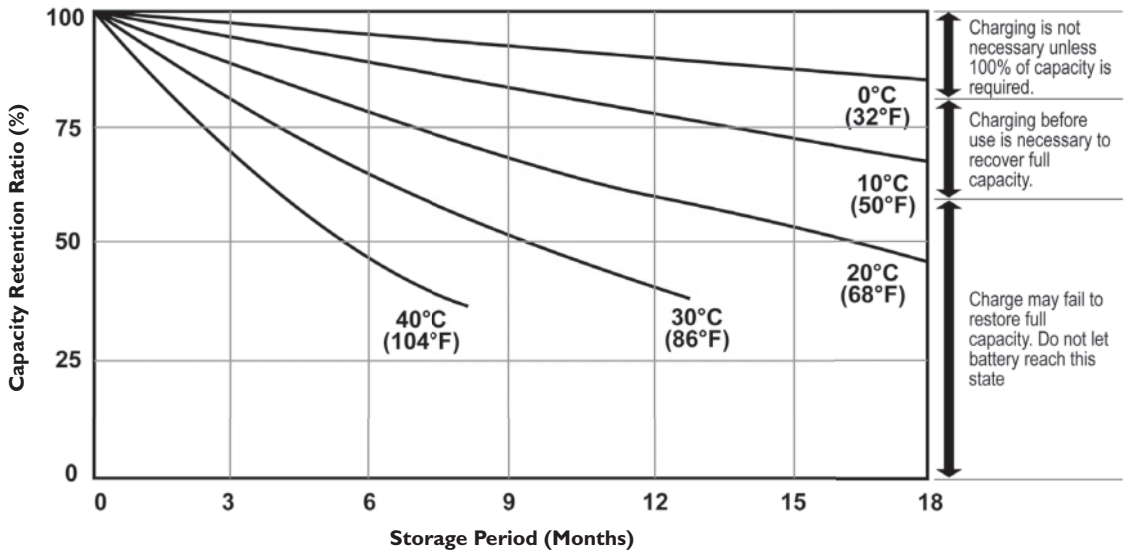
Some Factors Affecting Battery Life

1. Design (variations from one manufacturer to another)
2. Quality of materials (impurities / imperfections)
3. Production methods
4. Quality control
5. Cycling profile
6. Environmental operating conditions
7. Charging Regime

Self Discharge

Any charged battery tends to lose capacity over time. This capacity loss is referred to as Self Discharge and in lead acid batteries occurs due to the inherent instability of lead and lead dioxide in the presence of sulphuric acid. This results in the conversion of the cells active materials into lead sulphate which effectively discharges the cell. The rate of conversion increases with temperature.

Self Discharge Characteristics



Overcharging

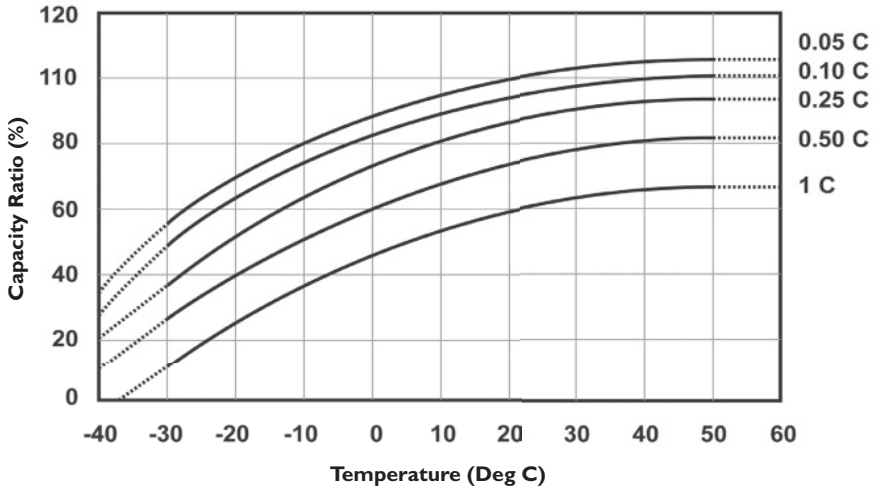
As a result of too high a charge voltage, excess current will flow into the battery after reaching full charge, causing decomposition of water in the electrolyte and premature aging. At high rates of overcharge a battery will progressively heat up. As it gets hotter, it will accept more current, heating up even further. This is called thermal runaway and it can destroy a battery in as little as a few hours.

Undercharging

If too low a charge voltage is applied, the current flow will essentially stop before the battery is fully charged. This allows some of the lead sulphate to remain on the electrodes, which will eventually reduce capacity. Batteries which are stored in a discharged state, or left on the shelf for long periods, will accept far less current than normal. This is caused by a phenomenon called "sulphation". Usually, the battery will start to accept increasing amounts of current until a normal current level is reached. If there is no response, even to charge voltages above recommended levels, the battery may have been in a discharged state for too long to recover.

Temperature Effects On Capacity

Actual capacity is a function of ambient temperature and rate of discharge. At 20°C (68°F) rated capacity is 100%. The capacity increases slowly above this temperature and decreases as the temperature falls. At any ambient temperature, the higher the rate of discharge, the lower the available capacity.



This relationship is illustrated in the above graph.

Applications

Applications can be classified under two basic categories:

- Standby (Float Charge)
- Cyclic

A float application requires the battery to be on constant charge with an occasional discharge whereas in a cyclic application the battery is charged and discharged on a regular basis.

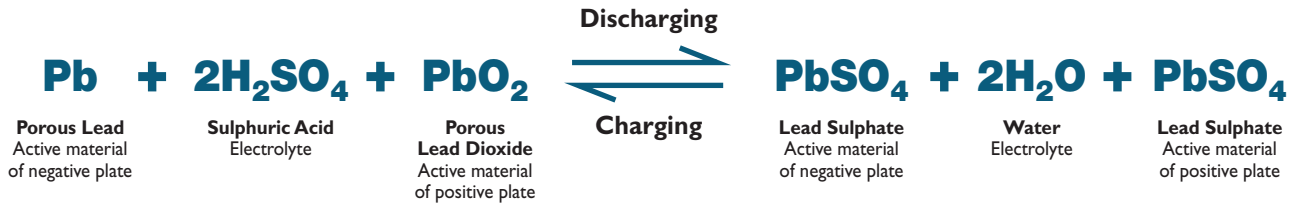
Typical Applications of Power Sonic Products

BATTERY SERIES / APPLICATION	PS 5 Yr Life (VRLA)	PS 10 Yr Life (VRLA)	PG 6-12 Yr Life (VRLA)	PG2v 15 Yr Life (VRLA)	PG FT 12 Yr Life (VRLA)	PSG (Gel) 10 Yr Life (VRLA)
Telecommunications	●	✔	✔	✔	✔	✔
UPS/Standby Power	✔	✔	✔	✔	✔	✔
Emergency Lighting	✔	✔	✔	✔	✔	✔
Fire and Security	✔	✔	●	●	●	●
Renewable Energy	●	●	✔	✔	●	✔
Mobility	●	●	●	●	●	✔
General Electronics	✔	✔	●	●	●	●
Utilities	●	●	✔	✔	●	✔

● Contact Power-Sonic for further application information

Basic Lead Acid Chemistry

The basic electrochemical reaction equation in a lead acid battery can be written as:



Discharge

During the discharge portion of the reaction, lead dioxide (PbO_2) is converted into lead sulphate ($PbSO_4$) at the positive plate. At the negative plate sponge lead (Pb) is converted to lead sulphate ($PbSO_4$). This causes the sulphuric acid (H_2SO_4) in the electrolyte to be consumed.

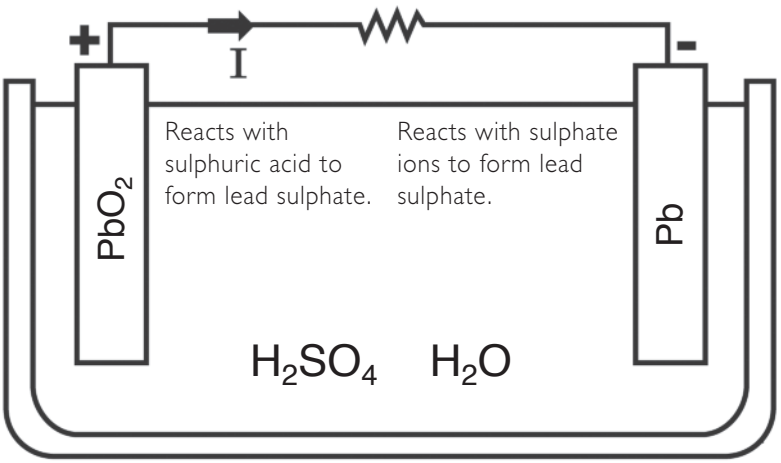


Figure 1: Chemical reaction when a battery is being discharged

Charge

During the recharge phase of the reaction, the cycle is reversed. The lead sulphate ($PbSO_4$) and water are electrochemically converted to lead (Pb), lead dioxide (PbO_2) and sulphuric acid (H_2SO_4) by an external electrical charging source.

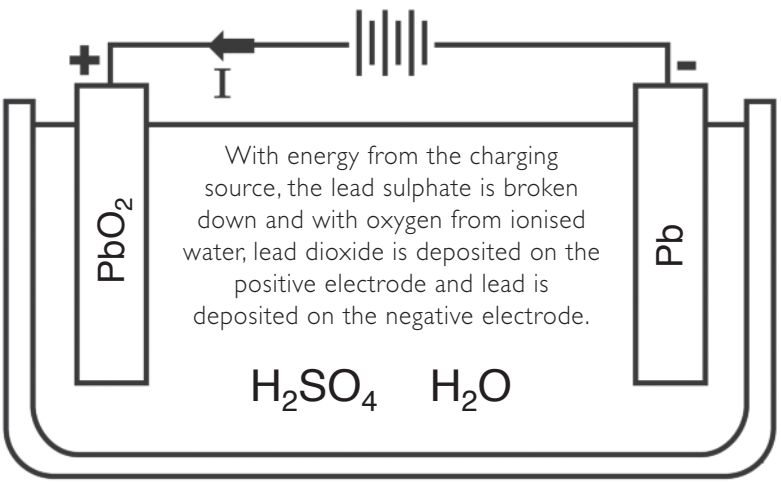
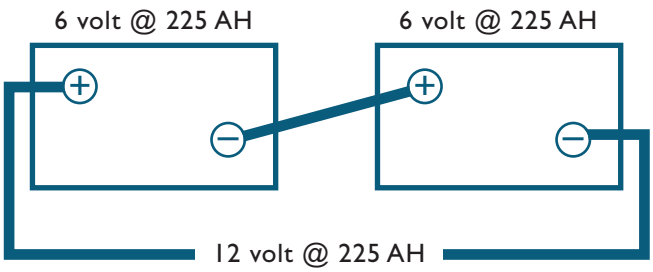


Figure 2: Chemical reaction when a battery is being charged

Connecting in Series

When connecting batteries in series the positive terminal of the first battery is connected to the negative terminal of the second battery and so on down the string.

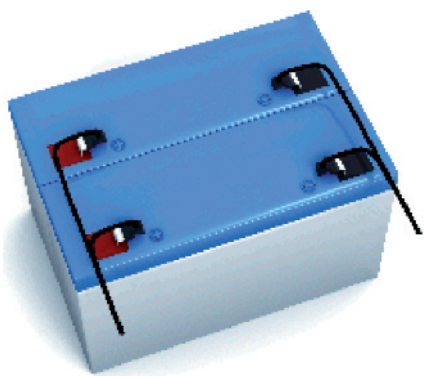
Series connection

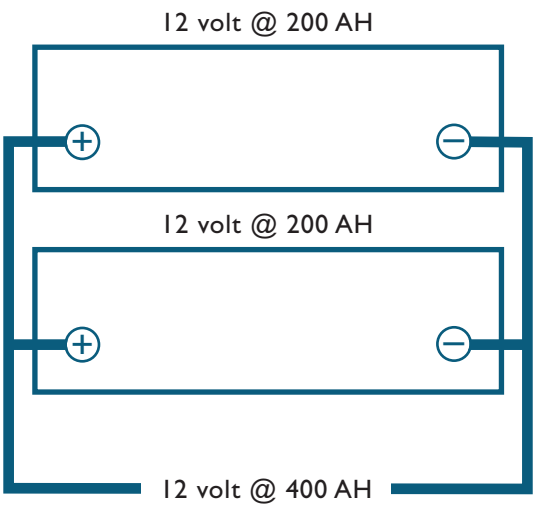


Connecting in Parallel

When connecting batteries in parallel (positive terminals are connected to the positive terminal and negative terminals to the negative), all batteries in the string will receive the same charge voltage but the charge current each battery receives will vary until equalization is reached.

Parallel connection





Note: A series connection increases the over all voltage of the battery string and a parallel connection increases the capacity.

Basic Battery Sizing

The below graph may be used for determining the appropriate battery size for a particular application, expressed in ampere hours of capacity.

Firstly 'look up' the required discharge current (plotted on the x –horizontal axis) and the required discharge time (plotted on the y-vertical axis). Where the current and time lines intersect, the diagonal Ah curve shows the minimum capacity required for the application. It should be noted that this is only a guide line and in practice, if the intersection point of the time & current does not fall exactly on a particular Ah curve, the next higher value Ah curve should be used to determine the minimum battery capacity/size.

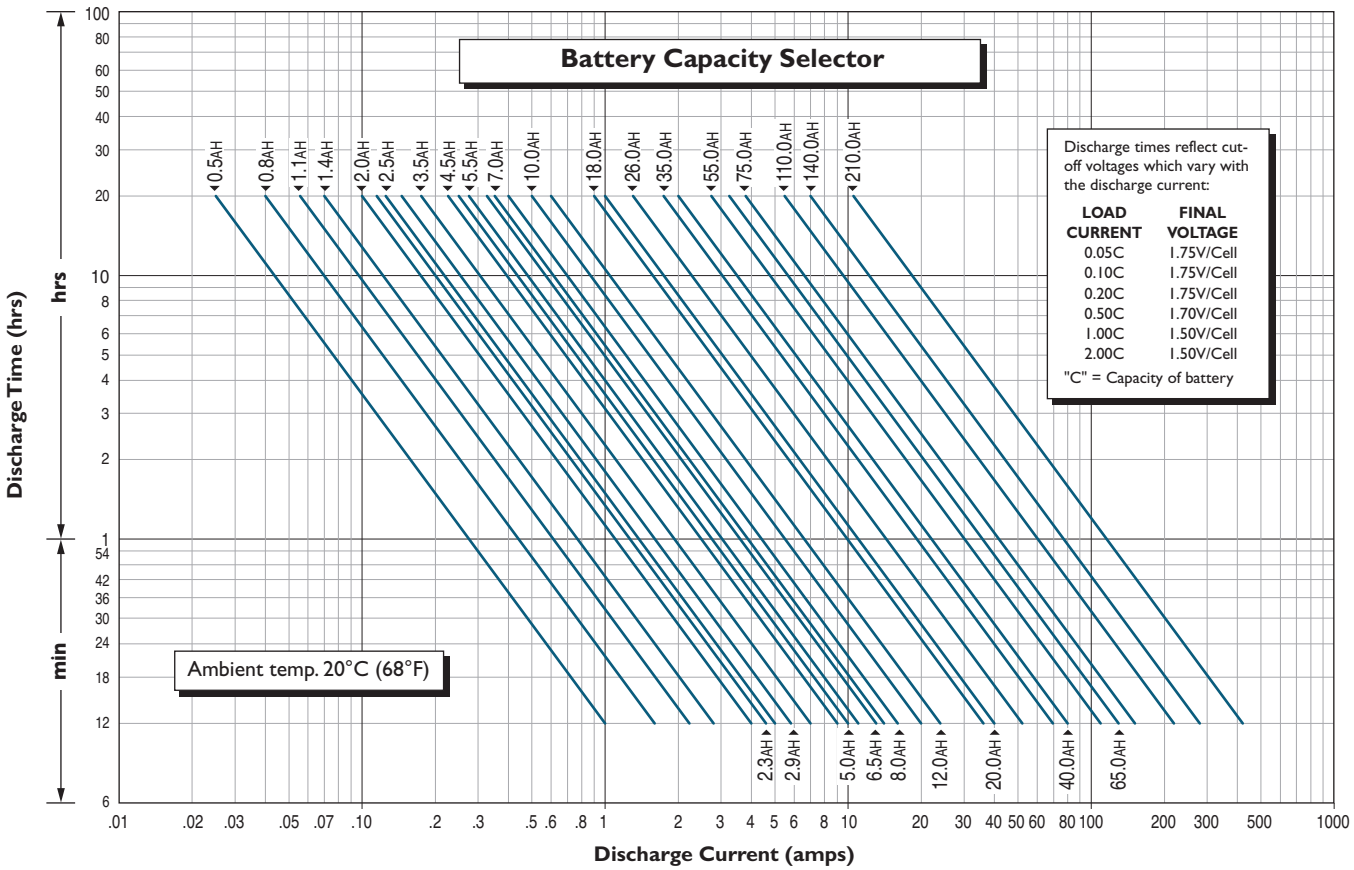
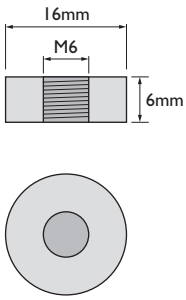


Figure 3: Capacity lines for Power-Sonic batteries

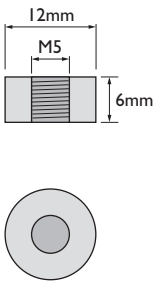
Figure 3 shows capacity lines for major Power-Sonic battery models with different ampere-hour ratings. Amperage is on the horizontal scale and the time elapsed is on the vertical scale; the product of these values is the capacity.

Terminal Details

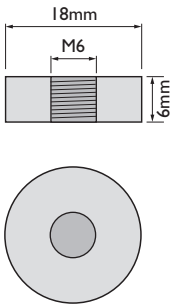
T6 Terminal



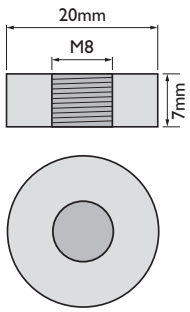
T12 Terminal



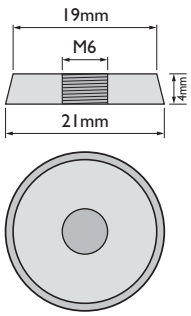
T7 Terminal

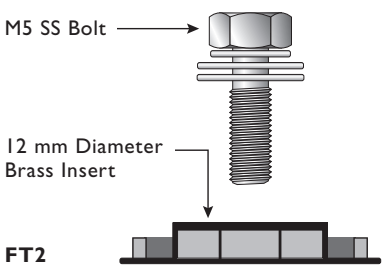


T11 Terminal

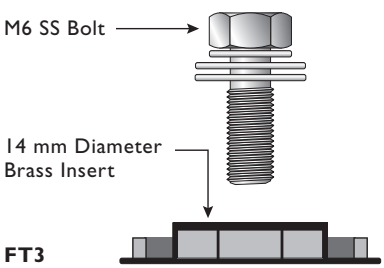


T13 Terminal

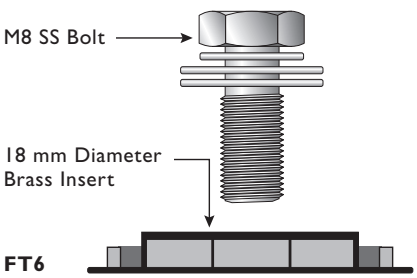




FT2



FT3



FT6

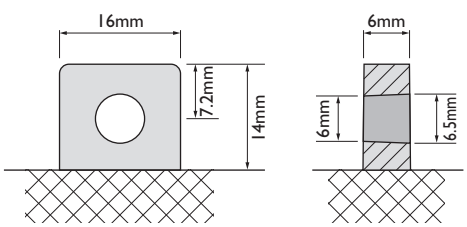
F1

FASTON
4.75mm X 0.8mm
quick disconnect tabs

F2

FASTON
6.35mm X 0.8mm
quick disconnect tabs

T5 Terminal



SP

SPRING TERMINALS
Fully collapsible positive and negative contacts

WL

INSULATED WIRE LEADS
With JST plug

Battery Construction

Terminals

Depending on the model, batteries come either with Faston type terminals made of tin plated brass, threaded insert type terminals of the same composition, or heavy duty flag terminals made of lead alloy. A special epoxy is used as sealing material surrounding the terminals.

Plates (electrodes)

Power-Sonic utilizes the latest technology and equipment to cast grids from a lead-calcium alloy free of antimony. The small amount of calcium and tin in the grid alloy imparts strength to the plate and guarantees durability even in extensive cycle service. In the charged state, the negative plate active material is pure lead and that of the positive lead dioxide. Both of these are in a porous or spongy form to optimize surface area and thereby maximizing capacity. The heavy duty lead calcium alloy grids provide an extra margin of performance and life in both cyclic and float applications and give good recovery from deep discharge.

Electrolyte

Immobilized dilute sulphuric acid: H_2SO_4

Relief Valve

In case of excessive gas pressure build-up inside the battery, the relief valve will open and release the pressure. The one-way valve not only ensures that no air gets into the battery where the oxygen would react with the plates causing internal discharge, but also represents an important safety device in the event of excessive overcharge. Vent release pressure is between 2-6 psi and the seal ring material is neoprene rubber.

Separators

Power-Sonic separators are made of absorbant glass fibre mat with high heat and oxidation resistance. The material further offers superior electrolyte absorption and retaining ability, as well as excellent ion conductivity.

Container & case sealing

Case and cover are made of non-conductive ABS plastic with flammability rating to UL94-HB or UL94 V-O. Depending on the model the case sealing is ultrasonic, epoxy or heat seal.

Examples of Applications

Power Sources
- Back-up Power
- Computers
- UPS

Communications
- GPS equipment
- Marine communications
- Telecommunication systems

Lighting
- Emergency Lighting
- Exit lights
- Hand held lights

Security Systems
- Burglar/Fire alarms
- Monitoring alarms
- Metal detectors

Automotive
- Electronic memory accessories
- Braking/fuel systems

Recreation
- Fish finders
- Ride-on-toys
- Electrical bicycles/scooters

Portable Equipment
- Audio-visual devices
- Test and measuring equipment
- Consumer electronics

Monitoring Equipment
- Fiber-optic test equipment
- Scientific Instruments
- Weather Instrumentation

Agricultural
- Livestock/game feeders
- Containment fencing

Military
- Aerospace
- Aircraft instrumentation
- Fire control systems

Miscellaneous
- Invisible fences
- DC power lifts
- Floor scrubbers
- Laser Products
- Robotics
- Advertising signs

Non SLA Battery Types

Power-Sonic are also suppliers of primary Alkaline cells and rechargeable Nickel Metal Hydride and Nickel Cadmium cell/batteries – further information is available by request.

Important Do's and Don'ts

Power-Sonic rechargeable sealed lead-acid batteries are designed to provide years of dependable service. Adherence to the following guidelines will ensure that battery life is maximized and operation is trouble-free.

Material Safety Data Sheets (MSDS)

- It is important that you familiarise yourself with these prior to handling, installing and disposing of all batteries. If there are any questions raised from these please contact Power-Sonics' technical department.

Handling

- Always wear insulated gloves when handling batteries; especially when connecting series and parallel groups of batteries.
- Follow all precautions as described in our Material Safety Data Sheets (MSDS). This information is subject to change depending upon government legislation. Visit our website: www.power-sonic.co.uk for up-to-date copies of these.
- If equipment is to be stored for a long period of time the batteries should be disconnected to avoid undue drain on the batteries and any potential for damage to the equipment.

Installation

- Fasten batteries tightly and make provisions for shock absorption if exposure to shock or vibration is likely.
- When installing the battery within a piece of equipment, fix it securely at the lowest practicable point.
- The battery should not be attached to any piece of equipment during "burn-in" testing.
- Do not apply undue force to the terminal or bend them. Avoid applying heat to the terminals through processes such as soldering.
- If soldering to the battery terminals is unavoidable it must be accomplished within 3 seconds, using a soldering iron no greater than 100 watts.
- Do not place batteries in close proximity to objects which can produce sparks or flames, and do not charge batteries in an inverted position.
- Avoid exposing batteries to heat! Care should be taken to place batteries away from heat-emitting components. If close proximity is unavoidable, provide ventilation. Service life is shortened considerably at ambient temperatures above 30°c (86°F).
- To prevent problems arising from heat exchange between batteries connected in series or parallel, it is advisable to provide air space of at least 0.4" (10mm) between batteries.
- Do not mix batteries with different capacities, different ages or of different makes. The difference in characteristics will cause damage to the batteries and possibility to the attached equipment.
- Battery cases and lids made of ABS plastic can sustain damage if exposed to organic solvents or adhesives.
- It is good practice to ensure that the connectors are re-torqued and the batteries are cleaned periodically.
- Do not attempt to open up batteries. Contact with sulphuric acid may cause harm. Should it occur, wash skin or clothes with liberal amounts of water. Do not throw batteries into fire; batteries so disposed may rupture or explode. Disassembled units are hazardous waste and must be treated accordingly.

Glossary

Gas Recombination
The process by which oxygen gas generated from the positive plate during the final stage of charge is absorbed into the negative plate, preventing loss of water.

High Rate Discharge
A very rapid discharge of the battery. Normally in multiples of C (the rating of the battery expressed in amperes).

Impedance
The resistive value of a battery to an AC current expressed in ohms (Ω). Generally measured at 1000Hz at full charge.

Internal Resistance
The resistance inside a battery which creates a voltage drop in proportion to the current draw.

Negative Terminal
The terminal of a battery from which electrons flow in the external circuit when a battery discharges. See Positive Terminal.

Nominal Voltage
The normal voltage of a lead-acid battery is 2 volts per cell.

Open Circuit Voltage
The voltage of a battery or cell when measured in a no load condition.

Overcharge
The continuous charging of a cell after it achieves 100% of capacity. Battery life is reduced by prolonged overcharging.

Parallel Connection
Connecting a group of batteries or cells by linking all terminals of the same polarity. This increases the capacity of the battery group.

Polarity
The charges residing at the terminals of the battery.

Positive Terminal
The terminal of a battery toward which electrons flow through the external circuit when the cell discharges. See Negative Terminal.

Rated Capacity
The capacity of the cell expressed in amphrs. Commonly a constant current for a designated number of hours to a specified depth of discharge at room temperature.

Recombination
The state in which the gasses normally formed within the battery cell during its operation are recombined to form water.

Series Connection
The connection of a group of cells or batteries by linking terminals of opposite polarity. This increases the voltage of the battery group.

Self Discharge
The loss of capacity of a battery while stored in an unused conditions without external drain.

Separator
Material isolating positive from negative plates. In sealed lead acid batteries normally is absorbent glass fibre to hold the electrolyte in suspension.

SLA Battery
Sealed lead-acid battery, generally having the following characteristics: Maintenance-free, leak-proof, position-insensitive. Batteries of this type have a safety vent to release gas in case of excessive internal pressure build-up. Hence also the term: Valve regulated battery.
"Gel Cells" are SLA batteries whose dilute sulphuric acid electrolyte is immobilised by way of additives which turn the electrolyte into a gel.

Service Life
The expected life of a battery expressed in the number of total cycles or years of standby service to a designated remaining percentage of original capacity.

Shelf Life
The maximum period of time a battery can be stored without supplementary charging.

Standby Services
An application in which the battery is maintained in a fully charged condition by trickle or float charging.

State of Charge
The available capacity of a battery at a given time expressed as a percentage of rated capacity.

Sulphation
The deposit of lead sulphate on the surface and in the pores of the active material of the batteries' lead plates. If the sulphation becomes excessive and forms large crystals on the plates the battery will not operate efficiently and may not work at all.

Thermal Runaway
A Condition in which a cell or battery on constant potential charge can destroy itself through internal heat generation.

Valve Regulated Lead Acid battery (VRLA)
See SLA Battery listed above.

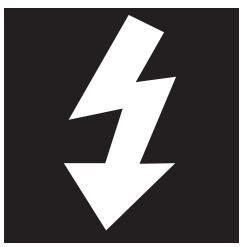
Battery Safety

Weight
Lead Acid Batteries are very HEAVY ! Take care when transporting, lifting and installing batteries. Also consider floor loadings of installations.

Sulphuric Acid

Electrolyte is very corrosive. Flush any acid splashes from eyes and off skin with plenty of clean water. Seek medical aid immediately. With flooded batteries, always wear safety glasses and protective clothing

Electrical Hazard
Batteries are always live. Only use fully insulated tools. Remove all rings, watches, necklaces and always wear safety glasses.



Explosive gases
Although sealed cells and batteries vent significantly less gas than other forms of lead acid batteries, the gases vented will contain hydrogen and oxygen.

These gases normally diffuse rapidly into the atmosphere however if a charger fails, causing higher than recommended rates, substantial volumes of explosive gases will vent from the battery.

When the concentration of hydrogen exceeds 4%, the atmosphere becomes explosive. Note: gas is only generated when cells are on charge but also can be present during discharge.

Recycling
Fortunately, scrap lead acid batteries can be safely recycled. In fact they have been recycled since the 1920's and today, lead acid batteries have a higher recycling rate than other waste products such as aluminium, paper and glass or plastic beverage containers.

For further information, please see:

- European directive 2006/66/EC on Batteries and accumulators and waste batteries
- The Batteries and Accumulators (Placing on the Market) Regulations 2008
- Reach (Registration Evaluation, Authorisation and restriction of Chemicals)

European Directives WEEE 2002/96/EC and ROHS 2002/95/EC

The ROHS directive covers the same scope as the WEEE directive. As Batteries and accumulators do not fall into any of the ten categories listed by the WEEE directive our products are considered to be outside the scope of each of these directives.

Power-Sonic Sealed Lead Acid and Nickel Cadmium batteries conform to the European Council directive 2006/66/EC, which specifies that batteries containing mercury, lead or cadmium should be collected separately when spent and should carry an identifying WEE Symbol, a crossed-out wheelie bin and the appropriate chemical symbol. This is designed to inform the end user to separate batteries from other waste.

Power-Sonic Europe's policy is to accept returns of our product at the customer's expense and to ensure proper recycling, we then route the batteries through Environment Agency procedures using approved waste carriers and licensed sites.

The Batteries and Accumulators (Placing on the market) Regulations 2008

The above regulations come into force on 26th September 2008 and are the legislation the UK Government is required to have in place to transpose EU Directive 2006/66/EC within this country.

Summarised below are Power-Sonic Europe Limited's obligations as a battery supplier regarding this legislation for placing batteries on the UK market.

Material Prohibitions

The only material within any of the technologies we place on the market that is potentially prohibited is that of Cadmium, in our Nickel Cadmium batteries. There is potentially a prohibition for these batteries, which contain more than 0.002% of cadmium. However, the prohibition does not apply to portable batteries intended for use in the following categories, which is the intended us for our batteries:

(a) Emergency and alarms systems, including emergency lighting
(b) Medical equipment
(c) Cordless power tools

Labelling to aid recycling

All Power-Sonic products are labelled according to current legislative requirements. These are the requirements to apply the crossed out wheeled bin symbol along with the appropriate chemical symbol for the item. These symbols are of the requisite size and are visible, legible and indelible. The relevant symbols for our batteries are:

Pb – VRLA (SLA) batteries
Cd – Nickel Cadmium batteries
NI – Nickel Cadmium batteries

There is no symbol as yet for alkaline batteries.

In addition to the above symbols, there will be a requirement by 26th September 2009 to show battery capacities. This is already shown on Power-Sonic batteries.

These regulations are designed to pave the way for producer responsibility to ultimately ensure the recycling of all batteries that reach their end of life – further consultation on the precise strategies to be adopted in order to work towards this objective are expected later. Power-Sonic Europe Ltd has for some years been making voluntary arrangements for the collection of the vast majority of our waste batteries. This has been achieved by the provision of waste bins at customer premises for our main product (VRLA Batteries), where volumes are sufficient, or by arranging collection from customers for delivery to our UK premises where the amount are more modest.

European Directive 2006/66/EC on batteries and accumulators and waste batteries

"The primary objective of this Directive is to minimize the negative impact of batteries and accumulators on the environment, thus contributing to the protection, preservation and improvement of the quality of the environment". This statement quoted from item 1 of the Directive summarizes its main aim.

Member States are required to produce legislation to introduce the objective of the Directive into national law by 26th September 2008. The UK government had produced **"The Batteries and Accumulators (Placing on the Market) Regulations 2008"** in order to transpose the directive within this country.

The main thrust of the legislation is to prohibit certain materials and ensure correct labelling of the various technologies that are placed on the market. The regulations are designed to aid and enforce the correct removal of waste batteries from equipment for disposal and recycling. Further consultation is expected on this later.

The labelling on Power-Sonic products conforms to the requirements of the above legislation. Prior to this Directive and subsequent UK legislation, Power-Sonic Europe Ltd has also had procedures in place for arranging the collection and recycling of the products it puts into the market.

Valve Regulated Lead Acid (VRLA), also known as Sealed Lead Acid (SLA) batteries
This is our main product line. In addition to the recycle symbol, these batteries are marked with the requisite symbol of the crossed out wheeled bin with the chemical symbol "Pb", which is of the required size, legible and indelible.

Since 2003 we have contracted with an approved waste service company to perform the necessary collection and re-cycling of these batteries by placement of collection bins at our customer's premises, should they desire such a service. The waste bins, approximately 1.2m (L) x 1.0m (W) x 0.8 (H) and designed to take up 1000kgs are available at no charge to our customers. Ideally, we like to place bins where they will be filled for collection at least 2 times per annum.

For customers who do not generate sufficient waste or do not have the space to accommodate a bin collection can be arranged. Upon receipt of waste at our premises, we will arrange correct disposal.

Nickel – Cadmium, Nickel Metal Hydride and Alkaline (primary) cells and packs.
Batteries and cells of these technologies cannot be put into the bins provided for Lead Acid Batteries. We currently ask that these are carefully packed and returned to our premises for subsequent input into the correct re-cycling system. Each technology must be kept separate. The label on the battery will identify the type, via the chemical symbol under the crossed out wheeled bin – "Cd" for Nickel Cadmium "NI" for Nickel Hydride. Alkaline batteries do not yet carry a symbol.

There are prohibitions on placing on the market batteries and accumulators (whether or not incorporated in appliances) containing Mercury and cadmium, listed in the above EU directive (Article 4). None of our current range contains Mercury.

The second prohibition is for batteries containing more than 0.002% of Cadmium (4:1b). Our Nickel Cadmium cell and battery pack come into the category. However, there is a clause (4:3) that allows for the non prohibition of our cells and batteries in the areas in which they are marketed:

(a) Emergency and alarm systems, including emergency lighting
(b) Medical equipment
(c) Cordless power tools

The exemption for (C) is to be reviewed in September 2010 (4:4).

August 2008

R.E.A.C.H. (Registration, Evaluation, Authorisation and restriction of Chemicals)

This is a new European regulation that came into force on June 1st 2007. A major aim is "to provide a high level of protection of human health and the environment for the use of chemicals".[1]

Whilst the regulation is primarily aimed at the chemical industry and sales of individual chemical substances, its scope includes what the regulations term "preparations" and "articles". This latter term is wide ranging and can include cars, telephones – and batteries[2]. However, under the section "substances in articles"[3] the following statement effectively exempts Power-Sonic from the obligation of registration of its products with the European Chemicals Agency (ACHA): "…notification is not required… when exposure to humans and environment can be excluded during normal conditions of use, including disposal".

Additionally, guidelines issued by "EUROBAT", which represents the European automotive and industrial battery industry has produced extensive guidelines which declare the battery industry, as a "downstream user" as having no registration obligations[4].

The guideline notes certain obligations that REACH defines for downstream users in their communications along the supply chain[5]. These involve the preparation and availability of EC safety data sheets. Power-Sonic Europe Ltd, has its Material Safety Data Sheets available on our web-site (**www.power-sonic.co.uk** under "**downloads**") or on request from our offices.

Substance of Very High Concern (SVHC)

Power-Sonic batteries do not contain any of the 16 SVHP's listed by ACHA press release, Helsinki, October 9th 2008.

January 2009

1. Health and Safety Executive web-site http://www.hse.gov.uk/reach/about.htm
2. Ibid.p.2
3. http://guidance.echa.europa.eu/substances_articles_en.htm
4. "Guidelines of EUROBAT for the Implementation of the European REACH Regulation Covering the Manufacture and Marketing of Batteries in the European Union – October 2008", Section 3 – available from www.eurobat.org or on demand from Power-Sonic Europe Ltd.
5. Ibid. Section 4.1.
6. http://echa.europa.eu/doc/press/pr_08_34_msc_identification_svhc_20081009.pdf

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